Naval Research Laboratory
Stennis Space Center, MS 39529-5004

NRL/MR-MM/7430--01-8548

Northern Gulf Littoral Initiative (NGLI), Geology and Physical Properties of Marine Sediments in the N.E. Gulf of Mexico: Data Report

William B. Sawyer
Chad Vaughan
Dawn Lavoie
Yoko Furukawa
Nancy Carnaggio
Jennifer Maclean
Eddie Populis

Seafloor Sciences Branch
Marine Geoscience Division

July 17, 2001

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave Blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	July 17, 2001	Multi-Media Report (May 25, 2000-Sept. 30, 2000)

4. TITLE AND SUBTITLE
Northern Gulf Littoral Initative (NGLI),
Geology and Physical Properties of Marine Sediments in the
N.E. Gulf of Mexico: Data Report

5. FUNDING NUMBERS
PE - OMN

6. AUTHOR(S)
William B. Sawyer, Chad Vaughan, Dawn Lavoie, Yoko Furukawa, Nancy Carnaggio, Jennifer Maclean, and Edward Populis

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Research Laboratory
Washington, DC 20375-5320

8. PERFORMING ORGANIZATION REPORT NUMBER
NRL/MR-MM/7430--01-8548

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Naval Oceanographic Office
N33T, Dr. John Blaha
Stennis Space Center, MS 39529-5004

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Northern Gulf Littoral Initiative (NGLI), http://www.navo.navy.mil/NGLI/

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

Sediment cores and grab samples were collected in the N.E. Gulf of Mexico for the purpose of categorizing the seafloor environment. This report presents results of shore-based analyses performed on the cores and grab samples. Interpretive results are not included. The unopened cores were continuously logged with a multisensor core logger, X-rayed for internal structure identification, and subsequently split opened where the core material was tested for mass physical and mechanical properties. This CD data report contains spreadsheets that include: the logged data (compressional wave velocity, bulk density by gamma-ray attenuation, derived porosity and acoustic impedance), the laboratory determined properties (natural water content, undrained shear strength, and particle size distribution parameters), core and grab sample photos, and maps of the surficial sediment properties.

14. SUBJECT TERMS
Acoustics
Marine geology
Sediment mass physical and mechanical properties
N.E. Gulf of Mexico
Marine geotechnique
Northern Gulf Littoral Initiative, NGLI

15. NUMBER OF PAGES
12

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std 239-18
298-102

NORTHERN GULF LITTORAL INITIATIVE (NGLI), GEOLOGY AND PHYSICAL PROPERTIES OF MARINE SEDIMENTS IN THE N.E. GULF OF MEXICO: DATA REPORT

The Naval Research Laboratory (NRL), Seafloor Sciences Branch, was tasked in calendar year 2000 to analyze sediment cores and grab samples collected by the Naval Oceanographic Office (NAVO) (Code N33T) in support of the Northern Gulf Littoral Initiative (NGLI), a multi-agency, regional scale modeling program.

(see http://www.navo.navy.mil/NGLI/main_frame.html).

One objective of the NGLI project was to establish a sedimentological and physical property database for Northern Gulf of Mexico that can be immediately utilized by the existing Navy R&D activities within the area. Results from the core and grab sample analyses will be used to populate this database.

NAVO's ambitious sampling efforts resulted in the recovery of over 50 sediment cores (averaging ~111 cm. in length), and 35 bottom grab samples during the 1999 and 2000 field seasons consisting of 6 separate sediment sampling cruises aboard the RV Pelican (LUMCON). NGLI bottom samples were collected in water depths ranging from ~3 to over 300 meters with an average depth of 36.5 meters.

NRL conducted non-destructive testing of the cores utilizing x-ray radiography and multi-sensor core logging to determine the structure and physical properties of the marine sediment cores. A *Geotek* Multi-Sensor core logger (Schultheiss and McPhail, 1989) was utilized to determine, and digitally log p-wave velocity (using a pair of 500 kHz piezo-electric ceramic transducers), wet bulk density by gamma-ray attenuation (using a 137-Cs gamma source and scintillation counter), core diameter deviation, and temperature at one centimeter intervals down-core. The core logger is highly automated, runs in a windowed PC

Manuscript submitted April 19, 2001.

environment, and stores raw data straight to computer disk where it can be further processed. Derivative acoustic impedance (g/m^2sec) and fractional porosity are additionally calculated and reported for each sample interval. Fractional porosity values are reported relative to an average grain density value of 2.65 g/cc, and a pore water density of 1.026 g/cc. P-wave velocity values are reported at a standard laboratory temperature of 23° C, and 35 °/₀₀ salinity.

Upon completion of the non-destructive testing, the core liners were split open along the length of the core with an electro-mechanical core liner splitter. Once the liners were split, the sediment core was then split apart utilizing an osmotic knife, which parts the cylinder of sediment into two equal halves while maintaining the visible structural detail within the sediment cores without the effect of smearing the split sediment surface. One half of the core was then photographed in ~20 cm/shot increments downcore, while the other half was used for physical properties and shear strength testing. Most of the processed core material is currently archived at NRL's core refrigerator facility at Stennis Space Center, MS.

One surficial sample (~0-5 cmbsf (centimeters below the seafloor) in sediment cores) was analyzed from each NGLI core and grab sample location for particle size distribution and mean grain size statistics. Classical sieving techniques were utilized for the sand sized sediments, and the fine particles (silt and clay) were measured via settling using pipette analysis and a Micromeritics Sedigraph (Model 5000). Grain size data are presented in phi (ϕ) values where $\phi = -\log_2(d\ (mm))$, (d = particle diameter). Equivalent particle size in millimeters is noted in the individual grain size histograms, and presented in the NGLI sediment map.

Undrained shear strength testing was conducted on cores containing cohesive marine sediments by using either a torvane, or a miniature laboratory vane shear apparatus. High resolution shear strength testing (5 miniature vane

samples in the upper 10 cm) was conducted in the uppermost 10 cm of each core sample. Below this 10 cmbsf level, the laboratory torvane was used to measure undrained shear strength at intervals of ~20cm to the end of the core. Most cores were considered sufficiently cohesive to run the shear tests. No strength measurements were made on grab samples because the samples were sandy and cohesionless.

Results from the core logging effort, the core and sediment laboratory analyses, and the textural classification of the sediment samples are presented on this compact disk (CD) data report. The CD contains 2 directories, one contains data, plots and photos, and the other contains maps. Core logger data, (p-wave velocity and relative amplitude, gamma density, fractional porosity, and acoustic impedance), and laboratory physical property data (natural water content and undrained shear strength values) are provided in a standard spreadsheet or workbook format that can be read by most software (see Appendix I data format details). Also presented are textural or grain size data and statistics for surficial samples from each NGLI sample location. Down-core photographic images, of the split core halves are also provided for each core (one lower resolution and one higher resolution jpeg formatted files in increments of ~20 cm. down-core). Photographs from grab sample sub-samples are also provided. Budgetary and time constraints prevented completion of creating scanned files of the core x-radiographs on this CD, however the x-ray films are available to be viewed at NRL.

Sub-directories (Gif, Jpg, and Png) in the map directory contain several very generalized regional maps depicting surficial sediment grain size characteristics (mean phi, % sand, and % clay) and spatial distribution, both seaward and inshore of the LA-MS-AL barrier islands. Additional data sources were combined with the NGLI grain size data to populate the 2D grid (using a natural neighbor gridding algorithym). Measured undrained shear strength values were used to construct a surficial sediment cohesion map (average

undrained shear strength value in the interval 0-10 cm) in the open Gulf of Mexico region of the NGLI domain (seaward of the barrier islands). ASCII grid files are also provided in the map directory on the CD with a readme file explaining the file format.

One important note here is that sample data used to construct the sediment maps vary greatly both in spatial data density, and temporally (significant historical data covering more than 20 years of varied sedimentological research was combined with the NGLI data set for purposes of constructing these maps). Because of these concerns, natural variability within marine sediments in the region is obviously not addressed by map content.

Data Sources and References

The authors are greatly appreciative to the following U.S. Government and State Agencies, universities, and individual researchers and authors who have assisted NRL in attempting to better define and understand the geological nature of bottom sediments and seafloor characteristics within the NGLI geographic domain.

1. NAVO Data Warehouse (Mark Geiger).
2. National Geophysical Data Center-NGDC DOC-NOAA, MS. Carla Moore
3. Gulf Coast Research Laboratory

   a.) USM Institute of Marine Sciences Dr. Ervin Otvos and Dr. D. Jay Grimes, marine sediment sample data.

   b.) Gulf Coast Research Laboratory, Sept. 1988, A Location Map of the Oyster Resource in Western Mississippi Sound, Project Leader W.J. Demoran.

4. MS Dept of Environmental Quality, Office of Geology Mr. Keil Schmid Provided 2 unpublished MS thesis with Mississippi waters sediment information:

   a.) Wilson, Andrew Moore, "Response Modeling of Holocene Sediments within the Shallow Substrate of Central Mississippi Sound", unpublished MS Thesis University of Mississippi, Department of Geology and Geological Engineering, 1984, 89 pp.

   b.) Chastain, David Lawrence, "Western Mississippi Sound: Analysis of Sedimentary Responses and Recent Deposition in a Semi-Enclosed Brackish Water Basin, Northeast Gulf of Mexico", unpublished MS Thesis University of Mississippi, Department of Geology and Geological Engineering, September 1981, 90 pp.

5. Environmental Monitoring and Assessment Program (EMAP), U.S. EPA/NHEERL/Gulf Ecology Division, Gulf Breeze, FL , MS Linda Harwell and MS Virginia Engle.
6. NGLI Sampling Cruises 1999-2000, Naval Oceanographic Office, Dr John Blaha and Carl Szczechowski, LUMCON RV Pelican.

7. Schultheiss, P.J., and S.D. McPhail, 1989. An automated P-wave logger for recording fine scale compressional wave velocity structures in sediments. In: W. Ruddiman, M. Sarnthein, et. al. (Eds.), Proc. ODP, Sci. Results, 108: pp. 407-413.

8. Thompson, M.J., W.W. Schroeder, N.W. Phillips, and B.D. Graham, 1999. Ecology of Live Bottom Habitats of the Northeastern Gulf of Mexico: A Community Profile. USGS/BRD/CR-1999-0001, OCS Study MMS 99-0004, 104 pp.

Appendix I

Data Format and Definitions

Sediment geoacoustic and physical property data from the multi-sensor core logger are reported down core in both decimal meter and centimeter intervals. Core section is indicated beginning with section one to section 'n' depending on core length and number of sections that were cut to length on the coring vessel (typically ~1 meter lengths). Core diameter deviation (mm) data are logged from output from linear voltage displacement transducers (LVDT) co-located with the acoustic transducer pair. This measure (core diameter deviation) takes into account small differences in acoustic travel path distance, and is used in the calculation of p-wave velocity down core. A relative amplitude value provides the logger operator and the data interpreter with a measure of how well the acoustic transducers are coupled with the core liner, and also how well the sediment fills the plastic core liner. P-wave velocity is measured using a pair of spring-mounted, oil-filled rolling acoustic transducers (500kHz) and is reported in m/s down-core. Gamma-ray density (analogous to wet bulk density) determined using gamma-ray attenuation is calculated from raw counts/second data and calibration values determined from a calibration water-filled core containing an aluminum (density ~2.7g/cc) slug of varying thickness. Acoustic impedance (g/m^2s) is calculated from the product of density and velocity. Fractional porosity is calculated from standard relationships of the soil skeleton and the water filling the voids in the sediment core. These relationships assume a selectable but constant sediment density (2.65 g/cc used here) and selectable water density (1.026 g/cc), and that the voids within the sediment are 100% saturated.

Note that the data have been edited and blank values, or no values usually indicate where the core logger system encountered acoustic coupling problems which usually occurred near the core tops and bottoms and/or near

core section breaks. The deleted data were usually erroneous p-wave velocity values and derivative acoustic impedance. Some of the cores had desiccated due to the length of time between core recovery and core logging. This resulted in poor acoustic coupling and no or unreliable p-wave velocity values being logged. The following spreadsheet sample is provided for clarification.

ALL NGLI SPREADSHEETS
Geotek MSCL Version 4.2 - 299C_1.OUT created at 11:25:56 on 07-12-2000.
299c1

Section Depth (m)	Section #	Section Depth (cm)	Core Diameter Deviation (mm)	relative p-wave amplitude	p-wave velocity (m/s)	gamma ray density (g/cc)	acoustic impedance (g/m2s)	Fractional Porosity
0.01	1	1	6.666	23				
0.02	1	2	6.667	46		1.263		0.8541
0.03	1	3	6.667	66	1617.811	1.4063	2275.142	0.7658
0.04	1	4	6.668	97	1641.96	1.4344	2355.198	0.7485

Undrained shear strength was measured on all cores except those where cohesionless sediments were encountered. For this study, a cohesionless sediment is considered one which contained less than ~25% mud. Intervals in the upper 10 cm of cores were measured for undrained shear strength using a miniature vane shear device with a vane rotation rate of 70 degrees/minute. A hand operated torvane was used for intervals further down-core. Results are reported in the following example in kilopascal units.

NGLI Shear Strength

Cruise (MO-YR)	Sample ID	Interval (cm)	Undrained Shear Strength (kPa)
2-99	G1	.75-2.0	2.74
		2.75-4	1.45
		4.5-5.75	2.62
		6.50-7.75	4.24
		8.5-9.75	4.64
		11-16	5.75

Natural water content (% dry weight) was determined on freshly split core halves, and are reported down core as shown in the following example spreadsheet.

NGLI Water Content

Cruise (MO-YR)	Core ID	Interval	Natural Water Content (%)
2-99	C1	0-1cm	33.70
		1-2cm	35.97
		2-3cm	43.30
		3-4cm	34.92
		4-5cm	28.19
		5-6cm	37.03
		6-7cm	47.20
2-99	C2	0-1cm	122.40
		1-2cm	136.99
		2-3cm	140.60
		3-4cm	141.13

For additional information please contact:

Bill Sawyer
NRL Code 7431
bill.sawyer@nrlssc.navy.mil
Voice 228-688-5233-Core Laboratory
FAX 228-688-5752

Or

Chad Vaughan
NRL Code 7431
chad.vaughan@nrlssc.navy.mil
Voice 228-688-5369
FAX 228-688-5752